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Petition to Make Application Special
according to 37 CFR 1.102 C

Respectfully submitted

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TRANSVERSE WATERCRAFT PROPELLER

BACKGROUND OF THE INVENTION

1. Cross-reference to related applications

The present application is a continuation-in-part of application Ser. No. 10/309897 filed on Dec. 5, 2002 which is a continuation-in-part of application Ser. No. 10/093731 filed on March 11, 2002 which is a continuation-in-part of International application PCT/US01/16526 filed on July 17, 2001, now International Publication (PCT) No. WO 02/08054 A1, which was published under PCT Article 21(2) in English.

2. Field of the invention

This invention relates generally to improvements in propeller systems for developing a propulsive force, and more particularly, it pertains to a new method and apparatus for propelling watercraft, such as boats, ships, ferries, rafts, fish-boats, dredges, tankers, tug-boats, etc.

3. Description of the Prior Art

Nowadays, the most common means for propelling watercraft are the screw type propellers which are mounted on the diving shafts disposed along the advancement direction of the watercraft. They displace the water backward as a result of orientation of the propeller blades with angles of incident relative to the advancement direction of the watercraft. That is why only the rearward component of the velocity of the water that is accelerated by the action of a screw propeller contributes to the desired thrust. A spinning screw propeller imparts a substantial outward radial velocity to water and the energy expended in causing this outward radial motion is wasted on rotation of water with formation of water disturbances such as visible wakes, vortices, cavitation, etc. That is why the thrust actually developed by the screw

propellers is far less than the amount that should be available from the shaft horsepower that creates it.

To improve such disadvantageous aspects of the screw propellers, various propulsion apparatus have been developed throughout the years which have transversely disposed axes of rotations of the blades (vertical or horizontal) for developing more effective propulsion force with lower speed of rotation. Numerous patents and researches have been devoted to development of propeller systems wherein the propeller blades are pivoted simultaneously with rotation of the driving shaft and to the problem of optimizing the cyclic variations of the orientation of individual blades. Some of such systems utilize rotation of propeller blades or paddles not only around the axis of the driving shaft but also around complementary axes of rotation. The basic concept presented in these systems is that the usable propulsive force is developed as a result of rotating the blades around two axes of rotation with variable orientation of the rotated blades relative to the driving shaft.

Propulsion apparatus are known (U.S. Patent Nos: 1,284,282 to Fitzpatrick, 1,450,454 to Roney, 1,667,140 to Clark, 1,923,249 to Abram) wherein blades of feathering type extend radially from the driving shaft and are rotated around radial axes simultaneously with rotation of the driving shaft. In the paddling position, the blades are held in a plane parallel to the axis of the driving shaft and in the feathering position, the blades are held in a plane perpendicular to the axis of the driving shaft. A serious drawback of such systems is that, in the process of changing from one position to the other, the blades have to be rotated 90 degrees around their longitudinal axes with a considerable resistance of the fluid and low paddling and propulsion efficiency during such rotation.

There are also known propulsion apparatus wherein the propeller blades are oriented and rotated in the planes parallel to the driving shaft (U.S. patent No. 3,270,820 to Frazier, British patent No. 217,223 to Pensovecchio). Although having advantages in respect

to the propellers with feathering blades, such apparatus with only two blades mounted in a plane perpendicular to the propeller shaft also have low efficiency and irregular power consumption. Different combinations of such propulsion apparatus are cumbersome and the mechanisms employed to effect their operations is complicated. For these reasons, a limited practical success has been obtained by such type of apparatus.

Another disadvantage of the conventional screw propellers is their vulnerability to underwater impact and damage when they are used in shallow water or in situations when there are different kinds of submerged debris such as tree logs, limbs, etc. Furthermore, the submerged screw propeller acts as a drag, considerably slowing the watercraft.

To solve this problem, the screw propeller can be mounted on the watercraft in such a position that a portion of the propeller blades rotate out of the water, as described, for example, in U.S. Patent No. 5,807,151 to Sumino. However, such a mounting of the screw propellers considerably reduces their propulsion efficiency. As a result, the usage of such water surface-piercing screw propellers remains restricted.

Different types of paddle-wheels which are used for propelling watercraft in shallow water or in the water containing dangerous debris, as disclosed, for example, in U.S. Patents Nos. 6,264,518 to Price and 6,447,352 to Nuss, also provide very low propulsion efficiency, speed and maneuverability for the watercraft.

The present invention seeks to overcome the deficiencies of known propulsion systems and to benefit from the advantages that may be expected from the new method and apparatus.

The object of the invention is to provide a reliable propelling apparatus with improved propulsion efficiency which can be mounted on the conventional outboard internal combustion engines or disposed directly on the transom of a boat. It can be used for propelling different types of the watercraft not only in the deep water, but also in the shallow water or other situations with possibility of damaging the propeller.

BRIEF SUMMARY OF THE INVENTION

The invention is based on my discovery that an effective propulsive force in a liquid fluid can be developed as a result of rotation of three, four, six or more substantially flat propeller blades or other similar propelling means simultaneously around at least two perpendicular axes with the same speed. One of these axes of rotation is disposed transversely to the advancement direction of the watercraft, preferably horizontally or vertically. The other one or more axes of rotation are disposed radially to that first transverse axis and are rotated together with the propeller blades in planes perpendicular to the transverse axis. The propeller blades are balanced relative to the axes of rotation and can be rotated simultaneously around that perpendicular axes without interfering with each other. During that rotations, the substantially flat surfaces of each propeller blades are oriented in the planes of rotation around the radial axis or disposed at acute angles with that planes. Preferably, the propeller blades have airfoil cross-sections in these planes.

In a preferred embodiment of the propulsion apparatus, one, two or more planetary gearboxes are fixed on a driving shaft or mounted on a support rod with ability to be rotated around their axes disposed transverse to the advancement direction of the watercraft. Two, three or four propelling means are mounted rotatably on each of the planetary gearbox. Each of the propelling means includes a substantially flat propeller blade which is balanced relative to the radial axis of rotation by a counter-weight. The propelling means are mounted on the radial output shafts of the planetary gearboxes and disposed perpendicular to the axes of these radial output shafts. Each propelling means extends in two opposite directions from a radial output shaft with its center of gravity disposed on the axis of that shaft.

The propelling means are constrained by the planetary gear engagements to rotate around the axes of the radial output shafts of the planetary gearboxes simultaneously with the rotation around the axis of the driving shaft or the support means. The planetary

gearboxes can be rotated by an internal combustion engine, an electric motor or any other types of drive.

The propulsion apparatus can be mounted on a conventional outboard engine or directly on the transom of a watercraft. Unlike conventional screw type propellers, the rotated planetary gearboxes with propelling means can be disposed not only under the water level but also over the water level because the propulsion thrust is developing by the propeller blades which extend substantially downwards. The disposing of the planetary gearboxes above the water surface eliminates its dragging in the water during the movement of the watercraft and improves the reliability of oil sealing elements and other details. Such propulsion apparatus can be particularly useful for propelling any existing or specially designed watercraft in shallow water or in the other situations when a conventional screw propeller can be easily damaged.

BRIEF DESCRIPTION OF THE DRAWINGS

A propulsion apparatus and other objectives of the present invention will become apparent from the following description taken in conjunction with preferred embodiments thereof with reference to the accompanying drawings, in which:

FIGS. 1 is a schematic perspective view of the preferred embodiment of the propulsion apparatus mounted on a outboard engine.

FIG. 2 is a partial vertical cross-sectional view along line II-II in FIG. 1.

FIGS. 3a, 3b, 3c, 3d are cross-sectional views along line III-III in FIG. 2 with different angle positions of the rotated planetary gearbox.

FIGS. 4a, 4b are schematic perspective views of another embodiment of the propulsion apparatus mounted on a outboard engine with different angle positions of the rotated planetary gearboxes.

FIG. 5 is a partial vertical cross-sectional view along line V-V in FIG. 4a.

FIG. 6 is a vertical cross-sectional view along line VI-VI in FIG. 5.

FIG. 7 is a vertical cross-sectional view along line VII-VII in FIG. 5.

FIG. 8 is a schematic perspective view of an embodiment of the propulsion apparatus mounted on the transom of a watercraft.

FIG. 9 is a horizontal cross-sectional view along line IX-IX in FIG. 8.

FIG. 10 is a vertical cross-sectional view along line X-X in FIG. 8.

FIG. 11 is a vertical cross-sectional view along line XI-XI in FIG. 8.

The identical details in all the drawings have the same designations.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to FIGS. 1, 2 and 3a, an outboard internal combustion engine 10 is mounted in a conventional manner on the transom 11 of a watercraft 12 with ability to be pivoted around a vertical axis 13 and a horizontal axis 14. A gearbox 15 mounted on the engine case extension 16 encloses a conventional bevel gear drive including a pinion bevel gear 17 which is fixed on the engine shaft 18 and is engaged with one of two driven bevel gears 19 or 20. A horizontal driving shaft 21 is mounted in the bearings 22 and 23 and is disposed transverse to the advancement direction of the watercraft 12. The bevel gears 19, 20 are keyed on the driving shaft 21 so that they can be moved along its axis to engage or disengage with the pinion bevel gear 17 for changing the direction of rotation of the driving shaft 21.

Two identical planetary gearboxes 24 and 25 are mounted on both sides of the gearbox 15. According to the preferred embodiment of this invention, each of the planetary gearbox has a cylindrical housing 26 with a central hub 27 which is fixed on the horizontal shaft 21. A cover 28 is secured to the cylindrical housing 26 by fasteners (not shown) and is mounted rotatably on the extension 29 of the gearbox 15. There is a sealing element 30 between the cover 28 and the extension 29. Each of the planetary gearboxes 24, 25 encloses a planetary bevel gear engagement comprising a sun bevel

gear 31 which is fixed on the extension 29 and three identical planet bevel gears 32, 33, 34 which are fixed on three radial output shafts 35, 36 and 37, respectively. Each of the planet bevel gears 32, 33, 34 is engaged with the sun bevel gear 31 at right angle with a one-to-one ratio. The radial output shafts are disposed substantially 120 degrees from each other. Each radial output shaft is mounted in two bearings 38 and 39 which are mounted in the housing 26 and on the central hub 27, respectively. The radial output shafts 35, 36, 37 extend out of the planetary gearbox through sealing elements 40. Three propelling means 41, 42 and 43 are affixed to the ends of the radial output shafts 35, 36, 37, respectively. They are disposed perpendicular to the axes of the radial output shafts and extend in two opposite directions from that shafts. Each of the propelling means 41, 42, 43 includes a propeller blade 41a, 42a or 43a which is balanced by one of the counter-weights 41b, 42b or 43b relative to one of the axes of the radial output shafts 35, 36, 37, respectively. The centers of gravity of the propelling means 41, 42, 43 are disposed on the axes of the radial output shafts 35, 36, 37, respectively. Three propeller means 41, 42, 43 disposed 120 degrees from each other are also balanced relative to the axis of the driving shaft 21.

The propeller blades 41a, 42a, 43a are substantially flat and are disposed in the planes of rotations around the radial output shafts 35, 36, 37, respectively, or at acute angles "a" with that planes. Preferably, they have airfoil cross-sections in these planes to reduce a resistance in the water during rotations around the radial output shafts. The gearbox 15 and the planetary gearboxes 24, 25 can be filled with a lubricating oil.

Those skilled in the art understand that the engine case extension 16 can be of any desired shape and size and the gearbox 15 can be mounted on that case extension at such a height that the driving shaft 21 and the planetary gearboxes 24, 25 will be disposed under the water level or over the water level.

In the operation, the planetary gearboxes 24, 25 are rotated by the driving shaft 21 in the direction of arrow R. Simultaneously

with rotating around the axis of the transverse horizontal driving shaft 21, the propelling means 41, 42, 43 are constrained by the planetary gear engagements of the planetary gearboxes 24, 25 to rotate around the axes of the radial output shafts 35, 36, 37 with the same rotational speed. As a result of such double rotations, the propeller blades 41a, 42a, 43a follow specific curved paths. In the positions when the propeller blades 41a, 42a, 43a are moving backward from the stern of the watercraft they extend substantively downwards and are oriented substantially perpendicular to this movement. Simultaneously, the propeller blades 41a, 42a, 43a are moving sideward relative to the advanced direction of the watercraft. As a result, a propulsion force for propelling the watercraft is developing. Both sides of each propeller blade are used consecutively as working surfaces for exerting the propulsion strokes during each turn of the driving shaft. During the rotations, radial extensions and circumferential velocities of the propeller blades relative to the axis of the driving shaft 21 are changing. As a result, the propeller blades are accelerated and decelerated which produces an additional propulsion effect.

When the propeller blades are moving in the advancement direction of the watercraft, they are oriented substantially in th plane of such movement with minimum resistance in the water and with reduced circumferential velocity around the driving shaft 21. The efficiency of the propulsion thrust developed in different angle positions of the rotated planetary gearboxes depends on the orientations of the propeller blades relative to the axes of the driving shaft 21 and relative to the advancement direction of the watercraft 12. The propulsion force is developing by the propeller blades when they extend substantially downwards, oriented substantially perpendicular to the advancement direction of the watercraft and are moving backwards relative to that direction. If the driving shaft and the planetary gearboxes are disposed over the water level, the propeller blades are plunged into the water in these positions. The sideward movement of the propeller blades relative to the advancement direction of the watercraft also

contribute to the development of the propulsion force.

Virtually no propulsion force is developing by the propeller blades when they are parallel to the axis of the driving shaft 21 because at such positions the propeller blades are moving in the advancement direction of the watercraft and are oriented so that have minimum resistance and relatively low speed in the water. If the driving shaft 21 and the planetary gearboxes are disposed over the water level the propeller blades which are parallel to the driving shaft are also disposed over the water level.

In order to facilitate the understanding of the development of the propulsion force, the movement of the propeller blades is explained with references to FIGS. 3a, 3b, 3c, 3d which illustrate the positions of the planetary gearbox 24 after each 30 degrees rotations in the direction of arrow R around the axis of the driving shaft 21. During each of these rotations, the propelling means 41, 42, 43 have also rotated 30 degrees clockwise around the radial output shafts.

The position shown in FIG. 3a corresponds to the position of the planetary gearbox 24 in FIGS. 1 and 2 when the propelling means 41 is in the upper part of the planetary gearbox 24 and is oriented parallel to the axis of the driving shaft 21. The propeller blade 41a extends in the direction opposite to the gearbox 15 and is moving along the arrow A (in FIG. 1) in the advancement direction of the watercraft being oriented so that it has minimum resistance in the water.

Two other propeller blades 42a and 43a extend substantially downwards because the propelling means 42, 43 are inclined only 30 degrees from the vertical directions being disposed on the ends of the radial output shafts 36, 37 which are, in this position, turned 30 degrees down from the horizontal positions. As a result of rotation of the planetary gearbox 24, the propeller blades 46, 47 are moving backwards from the stern of the watercraft along the arrow B being oriented substantially perpendicular to this direction. The propeller blades 42a, 43a are also moving sidewards in opposite directions along the arrows C, D with minimum

resistance in the water to such sideward movements. The propulsion force is exerted as a result of such a combine movement of the propeller blades.

To prevent the possibility of interfering in such positions of the planetary gearboxes, the propeller blades can be disposed at acute angles "α" with the planes of rotation around the radial output shafts. The propeller blades 42a and 43a can be parallel to each other in this position of the planetary gearbox if the angles "α" are about 25-28 degrees.

In the position shown in FIG. 3b, the propelling means 42 extends vertically downwards. As a result of rotating by the driving shaft 21, the propeller blade 42a is caused to move backward from the stern of the watercraft being oriented substantially perpendicular to the direction of this movement. Simultaneously, the propeller blade 42a is moving sideward because it is rotated around the radial output shaft 36. As a result, an effective propulsion force for propelling the watercraft is developing.

The other two propelling means 41, 43 are inclined only 30 degrees from their positions parallel to the driving shaft 21 and the movement of the propeller blades 41a, 43a in this position virtually do not have a considerable influence over the developing the propulsion force. If the planetary gearboxes are disposed over the water level, the propeller blades 41a, 43a in this position are also disposed substantially over the water level.

In the position of FIG. 3c, which corresponds to a mirror position of the planetary gearbox 25 in FIGS. 1 and 2, the propelling means 43 is disposed in the lower part of the planetary gearbox and is oriented parallel to the driving shaft 21. The propeller blade 43a extends toward the gearbox 15 and is moving along the advancement direction of the watercraft with minimum resistance in the water. As shown in FIGS. 1 and 2, the propeller blades in such positions can pass under the gearbox 15 without interfering with it if the planetary gearboxes 24, 25 are mounted in close proximity to the gearbox 15.

Two propelling means 41, 42 extend substantially downward in this position. As a result of the rotation around the axis of the driving shaft 21, the propeller blades 41a, 42a are moving substantially backward from the stern of the watercraft. The blades are oriented at some angles with the direction of their backward movements. Nevertheless, they are capable to exert the propulsion force. However, in such positions the efficiency of the developing propulsion force is the lowest in compare with the other angle positions of the rotated planetary gearboxes. If the driving shaft 21 and the planetary gearboxes 24, 25 are mounted over the water level, the propeller blades can also be disposed in this position substantially over the water level.

In the position of FIG. 3d, the propelling means 41 extends vertically downwards. The propeller blade 41a is moving backwards from the stern of the watercraft as a result of rotation around the driving shaft 21 being substantially perpendicular to such direction and exerts an effective propulsive force, while the propeller blades 42a, 43a are in the positions when they virtually do not influence considerably on the development of the propulsion force.

After turning of the planetary gearbox next 30 degrees from the position of FIG. 3d, the propeller blades will be in the positions similar to their positions shown in FIG. 3a and the described movement of the propeller blades will repeat during all the rotation of the driving shaft 21.

A propulsion thrust for propelling the watercraft is developing virtually in any angle position of the planetary gearbox. However, the efficiency of the propulsion thrust in different positions depends on the orientation of the propeller blades at that moment. However, those knowledgeable in the art will understand that with two planetary gearboxes 24 and 25 rotated simultaneously, it is possible to adjust their angle positions relative to each other on the driving shaft 21, so that six propeller blades 41a, 42a, 43a, 41a', 42a', 43a' can exert the propulsion strokes consecutively. When one of the planetary gearboxes is in a position with the

propeller blades developing the maximum propulsion force, the other one can be in a position wherein the lowest propulsion force is developed. As a result, a virtually permanent propulsion thrust for propelling a watercraft can be developed with the substantially equalized power consumed by the engine 10.

FIGS. 4a, 4b, 5, 6 and 7 illustrate another embodiment similar to the described propulsion apparatus but having only two propelling means mounted on each planetary gearbox. An internal combustion engine 10 having the engine case extension 16 and the gearbox 15 is mounted on the transom 11 of a watercraft 12 as previously described. Two planetary gearboxes 44 and 45 are mounted on the gearbox 15. In FIGS. 4a and 4b they are shown in two angle positions turned 90 degrees from one position to another. As shown in FIGS. 5-7, each planetary gearbox has a cylindrical housing 46 with a central hub 47 and a cover 48 and encloses two radial output shafts 49, 50 disposed along a common axis perpendicular to the driving shaft 21. Each radial output shaft is mounted in two bearings 51, 52 and extends out of the planetary gearbox through a sealing element 53. The planetary bevel gear engagement in each planetary gearbox 44 and 45 includes a sun bevel gear 54 fixed on the extension 29 of the gearbox 15 and identical planet bevel gears 55, 56 fixed on the radial output shafts 49, 50, respectively. Each planet bevel gear is engaged with the sun bevel gear 54 at right angle with one-to-one ratio. The horizontal transverse driving shaft 21 and the planetary gearboxes 44, 45 can be disposed under the water level or over the water level as in the previously described embodiment.

Two propelling means 57, 58 or 57', 58' are mounted on each of the planetary gearboxes 44 and 45, respectively, perpendicular to the radial output shaft to which they are affixed. The propelling means 57, 58, 57', 58' include substantially flat propeller blades 57a, 58a, 57a', 58a' which are balanced relative to the axes of rotation of the radial output shafts by a counter-weight 57b, 58b, 57a', 58b', respectively. The propeller blades are oriented substantially in the planes of rotation around the radial output

shafts. Preferably, they have an airfoil section in these planes. The gearbox 15 and the planetary gearboxes 44, 45 can also be filled with a lubricating oil.

In the operation, the horizontal shaft 21 is rotated together with the planetary gearboxes 44, 45 in the direction of arrow R by an internal combustion engine 10 through the gearbox 15. The propelling means 57, 58 and 57' 58' are constrained by the planetary gearboxes 44, 45 to rotate around the axes of the radial output shafts with the rotational speed of the driving shaft 21. Two propelling means mounted on the same planetary gearbox are rotated in parallel planes in opposite directions. The planes of rotation of the propelling means mounted on the different planetary gearboxes are substantially perpendicular to each other. The propeller blades 57a, 58a and 57a', 58a' are oriented so that during the rotations they do not interfere with each other and with the gearbox 15 even if they are mounted in close proximity with the gearbox 15.

During each 360 degrees turn of the horizontal shaft 21, four propulsion strokes are exerted which follow consecutively one after another. Each propulsion stroke is exerted by the movement of two propeller blades 57a, 58a or 57a', 58a' when they are moving backwards from the stern of the watercraft being oriented substantially perpendicular to such a movement. During the forward movement of the propeller blades, they are oriented in the plane of such movement with minimum resistance in the water. If the driving shaft 21 and the rotated planetary gearboxes 44, 45 are disposed over the water level, the propeller blades 57a, 58a, 57a' and 58a' are plunged into the water for exerting the propulsion force.

FIGS. 8-11 illustrate one more embodiment of a propulsion apparatus according to the present invention wherein a planetary gearbox 59 is rotatably mounted on a support rod 60 which is fixed horizontally to the transom 11 of a watercraft 12 on two brackets 61 and 62. As shown in FIGS. 9 and 10, the planetary gearbox 59 includes a housing 63 having a central hub 64 (which can be made integrally with the housing) and a cover 65. The support rod 60

extends through a sealing elements 66 and 67 in the housing 63 and in the cover 65 of the planetary gearbox, respectively. The housing 63 encloses a planetary bevel gear engagement which includes a sun bevel gear 68 fixed on the support rod 60. Four identical bevel gears 69, 70, 71, 72 are fixed on the radial output shafts 73, 74, 75, 76, respectively, and engaged with each other. Two planet bevel gears 77, 78 are fixed on the radial output shafts 73, 74, respectively, and are engaged with the sun bevel gear 68 with one-to-one ratio. Each of the radial output shafts 73, 74, 75, 76 is mounted in two bearings 79 and 80 and extends through the sealing elements 81 in the housing 63. Four propelling means 82, 83, 84, 85 are affixed to the ends of the radial output shafts 73, 74, 75, 76, respectively, and disposed with extensions in opposite directions perpendicular to the radial output shaft. The propelling means 82, 83, 84, 85 include the propeller blades 82a, 83a, 84a, 85a which are balanced by a counter-weight 82b, 83b, 84b, 85b, respectively, relative to the axes of the radial output shafts. The planetary gearbox 59 are filled with a lubricating oil.

In a preferred embodiment of such a propulsion apparatus, the planetary gearbox is rotated by an outer rotor type brushless electric motor. Two casings 86, 87, made from a non magnetic material, such as aluminum, are mounted on the support rod 60 with ability to be rotated in the bearings 88, 89 and are fixed to the housing 63 and the cover 65 of the planetary gearbox 59, respectively. A plurality of permanent magnets 90 are disposed along the inner periphery of the casings and form the outer rotors.

Two inner stators 91, 92 are secured to the support rod 60 and can be of any conventional type. Preferably, the inner stators 91, 92 can be manufactured from laminated ferromagnetic material. As shown in FIG. 11, a plurality of protrusions 93 disposed radially around the support rod 60 are serving as cores for electric coils 94 which are connected electrically to a battery or any other source of electric power. There are axial holes 95, 96, radial holes 97, 98 in the support rod 60 and also the longitudinal passages 99, 100 in the support brackets 61, 62, respectively, to

allow the terminal leads of the electric coils 94. The outer periphery of the protrusions 93 faces the inner periphery of the permanent magnets 90 across a small air gap 101. The inner stators 91, 92 generate a rotating electromagnetic field enabling to rotate the planetary gearbox 59 through the outer rotors wherein the casings 86, 87 work like a kind of hollow driving shafts.

During the operation, the planetary gearbox 59 is rotated in the direction of an arrow R. The propeller blades 82a, 83a, 84a and 85a are constrained by the planetary gearbox 59 to rotate simultaneously around the axis of the support rod 60 and around the axes of the radial output shafts 73, 74, 75, 76 of the planetary gearbox 59 with the same rotational speed. The propeller blades adjacent to each other in the perpendicular planes are rotated in opposite directions (clockwise and counter-clockwise) not interfering with each other. After each 90 degrees of rotation of the gearbox 59, two propeller blades are oriented substantially downwards and are plunged into the water for exerting the propulsive force, while the other two propeller blades are disposed substantially horizontally over the water level.

During each turn of the planetary gearbox 59, four propulsion strokes are exerted which follow consecutively one after another. Each propulsion stroke is exerted by two propeller blades 82a, 83a or 84a, 85a. Both sides of the blades are used consecutively as working surfaces. During backward movement astern, the propeller blades are always oriented substantially perpendicular to such movement exerting the propulsion force propelling the watercraft. The forward moving propeller blades are always oriented in the plane of such movement with minimum resistance in the water. When the orientations of the blades are changing from the horizontal to the downward position, the circumferential velocity of their rotations around the axis of the driving shaft is increased.

While this invention has been described with reference to the structures disclosed herein, they are merely chosen and described to illustrate the principle, applications, and practical use of the invention to thereby better enable others skilled in the art to

utilize this invention. The preferred embodiments of the present invention illustrated in FIGS. 1-11 are not confined to the details as set forth and are not intended to be exhaustive or to limit the invention to the precise form disclosed. For example, an embodiment of the propulsion apparatus described with electrical drive can be used with an internal combustion engine or any other type of drive. The invention is intended to cover any modifications, which may be variously practiced within the scope of the following claims or their legal equivalents, rather than by examples given.